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Seed crops and regeneration problems of 19 species in Northeastern Wisconsin

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SEED CROPS AND REGENERATION PROBLEMS OF 19 SPECIES IN NORTHEASTERN WISCONSIN

Richard M. Godman and Gilbert A. Mattson

Annual reports were published from 1949 through 1962 to provide the first long-term data on the frequency and size of seed crops for different regions in the Lake States. Although these were discontinued on a regional basis (Rudolf 1963), annual reports have been maintained for 19 species[1/] on the Argonne Experimental Forest in northeastern Wisconsin for use with natural regeneration studies. Thus we now have a 26-year record for this locality.

The timber stands on the Argonne Experimental Forest are primarily of second-growth seedling origin that have developed following commercial cutting about 1905. Within this glaciated area, the upland topography tends to have well drained silt-loam soils that support a mixture of species having average site indices. Their tree diameters range up to the large saw log size. The lowland topography generally supports the mixed-conifer-swamp types although the jack pine and red pine types are found on the drier, sandy sites. The ratings in table 1 are based on the main canopy trees in these types.

SEED CROP FREQUENCY

As shown in table 2, the most consistent producers were quaking and bigtooth aspen. Both had good or better crops in about 2 of every 3 years. Only three fall-maturing species--American basswood, eastern hemlock, and northern white-cedar--approached this frequency. Good or better seed crops occurred in about 1 out of 2 years in four species--red maple, American elm, balsam fir, and black spruce. All of the remaining 10 species except black ash and red pine produced good or better seed crops about 1 of every 3 years.

Bumper crops occurred in all species except jack pine. Usually, they occurred less frequently than did the good crops except in white spruce, northern white-cedar, American basswood, yellow birch, and red pine. The most consistent seed producers, the two aspens, each had only one bumper crop.

INTERVAL BETWEEN SEED CROPS

As shown in table 3, good or better seed crops occurred at different intervals in northeastern Wisconsin than those reported by Fowells (1965), U.S. Dep. Agric. (1974), and Wang (1974). These were shorter for 11 species, longer for 5 species, and about the same for 3 species. The greatest differences occurred in the aspens and in black spruce.

As shown in the following tabulation, successive years of good or better seed crops occurred in all species except red pine.

Species	*Good or better*[2/]	*Poor or fail*[2/]
Spring-maturing species		
Quaking aspen	6	2
Bigtooth aspen	6	2
Red maple	4	5
American elm	3	5
Fall-maturing species		
Hardwoods		
Sugar maple	2	2
Yellow birch	2	3
Paper birch	2	5
American basswood	3	2
White ash	2	4
Black ash	2	7
Northern red oak	3	2
Conifers		
Eastern hemlock	5	2
Balsam fir	3	2
Northern white-cedar	6	2
Eastern white pine	2	3
Red pine	1	2
White spruce	2	3
Black spruce	5	1
Jack pine	7	2

1/ *Common and scientific names are listed on page 5.*

2/ *Good or better = 61 to 100 percent of full crop; poor or fail = less than 36 percent of full crop.*

Table 1.--*Yearly ratings[1/] from 1949 through 1974 for seed crops of 19 tree species in northeastern Wisconsin*

Species	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
SPRING-MATURING SPECIES																										
Quaking aspen	--	G	G	G	G	G	G	M	G	G	G	G	--	G	G	G	F	F	G	P	P	B	G	M-G	F	G
Bigtooth aspen	--	G	G	G	G	G	G	M	G	G	G	--	--	M	G	G	F	F	G	P	P	B	G	M-G	F	G
Red maple	--	M	M	G	G	G	B	--	--	--	--	G	M	M	G	G	F	P	P	F	P	B	B	F-P	G	B
American elm	F	--	M	--	--	--	B	--	--	G	G	G	M	G	P	G	F	F	F	F	F	B	M	B	P-F	B
FALL-MATURING SPECIES																										
Hardwoods																										
Sugar maple	F	M	P	G	G	M	M	G	F	G	P	G	P	M	P	B	F	F	G	F	P	B	B	F	F-P	B
Yellow birch	F	B	M	P	G	M	G	P	M	M-G	B	B	F	G	M	G	F	F	B	F	P	P	B	F-P	F-P	G
Paper birch	F	B	--	F	G	P	G	--	M	M-G	M	G	F	G	M	M	F	F	P	F	P	P	G	F	F-P	B
American basswood	F	G	B	B	P	B	G	P	M	G	B	B	P	G	M	B	P	G	M	G	P	G	G	P-M	B	B
White ash	G	G	P	F	F	M	P	G	P	M-G	B	G	P	F	B	B	F	P	P	F	G	F	B	P-F	G	F
Black ash	G	B	M	F	F	P	--	G	P	P-M	P	P	F	F	M	B	F	G	P	F	G	F	P	F	F-P	F
Northern red oak 2/	P	P	G	G	--	--	--	--	--	P	P	G	M	M	P	M	P	F	G	B	P	M	P	B	G	B
Conifers																										
Eastern hemlock	P	G	P	G	B	P	G	P	--	G-B	M	G	F	G	G	G	P	P	G	M	M	G	G	G	G-B	G
Balsam fir	F	B	--	M-G	G	F	G	F	P	G-B	G	G	F	G	P	B	F	F	G	F	M	F	B	F	B	B
Northern white-cedar	F	B	M	G	G	M	G	B	M	B	P	B	--	G	P	M	F	F	B	G	B	B	B	F	G	B
Eastern white pine 2/	P	G	P	P	G	P	P	F	G	P-M	B	G	F	P	F	M	G	P	B	G	B	G	P	F	G	B
Red pine 2/	F	M	--	P	P	G	F	F	B	P-F	P	M	F	F	M	G	M	P	F	M	B	G	P	F-P	F	B
White spruce	F	B	--	P-M	M	G	G	M	F	P-M	P	B	F	F	M	G	F	F	B	B	F	P	P	B	P-M	B
Black spruce	F	B	--	G	M	M	G	M	F	M-G	G	G	F	F	M	B	B	F	G	M	P	G	G	G	G	G
Jack pine 2/	F	G	M	M-G	M	G	M	P	P	M	P	G	F	M	M	G	F	M	M	G	P	G	G	G	G	G-B

1/ B = Bumper, 91-100 percent of a full crop; G = Good, 61-90 percent of a full crop; M = Medium, 36-60 percent of a full crop; P = Poor, 16-35 percent of a full crop; F = Failure, 0-15 percent of a full crop; -- No report.

2/ Requires 2 years to mature.

Table 2.--*Percentage of good or better, medium, and poor annual crops produced by 19 northeastern Wisconsin species for the period 1949-1974*

Species	Years observed	Good+[1/]	Medium	Poor
		- - - *Percent* - - -		
Spring-maturing species				
Quaking aspen	24	71	8	21
Bigtooth aspen	23	65	13	22
Red maple	21	48	24	28
American elm	20	45	15	40
Fall-maturing species				
Hardwoods				
Sugar maple	26	38	16	46
Yellow birch	26	38	19	43
Paper birch	24	38	16	46
American basswood	26	62	7	31
White ash	26	38	8	54
Black ash	25	28	4	68
Northern red oak[2/]	21	38	19	43
Conifers				
Eastern hemlock	25	60	12	28
Balsam fir	25	52	4	44
Northern white-cedar	25	64	16	20
Eastern white pine[2/]	26	39	15	46
Red pine[2/]	25	16	24	60
White spruce	25	40	12	48
Black spruce	25	52	24	24
Jack pine[2/]	26	42	35	23

1/ Good+, 61 to 100 percent of full crop; Medium, 36-60 percent; Poor, less than 36 percent.

2/ Requires 2 years to mature.

The occurrence and duration of repeated crops were most frequent in the aspens, several conifers, and basswood; it was least frequent in other fall-maturing hardwood. The longest period of successive good or better seed crops was 7 years in jack pine, followed by 6 years in both aspens and northern white-cedar, and 5 years in eastern hemlock and black spruce. Consecutive bumper seed crops occurred at least once in eight species; one 3-year period occurred in white-cedar. Three successive 2-year bumper crops occurred in basswood.

All species, except black spruce, had successive years of poor crops or failures. The longest consecutive period was 7 years in black ash followed by 5 years in paper birch, American elm, and red maple and 4 years in white ash. In other species, the duration of poor crops seldom exceeded 2 years. The 5-year period 1965 through 1969 was exceptionally poor for all species.

SILVICULTURAL CONSIDERATIONS

In northeastern Wisconsin, only sugar maple reproduces in abundance on unscarified

Table 3.--*Ranges of good or better seed crops for 19 species in northeastern Wisconsin during the period 1949-1974 as compared with ranges reported for same species in the United States and Canada*

(In years)

Species	:Northeast Wisconsin[1]/	:United States[2]/	:Canada[3]/
Spring-maturing species			
Quaking aspen	1-3(1.4)	4-5	4-5
Bigtooth aspen	1-3(1.5)	4-5	4-5
Red maple	1-6(2.1)	1	2+
American elm	1-6(2.2)	--	1
Fall-maturing species			
Hardwoods			
Sugar maple	1-4(2.6)	2-5	3-7
Yellow birch	1-4(2.6)	1-2	2
Paper birch	1-8(2.7)	1	1-2
American basswood	1-3(1.6)	1	2
White ash	1-6(2.6)	--	3-5
Black ash	1-8(3.6)	--	2
Northern red oak	1-7(2.6)	2-5	2-3+
Conifers			
Eastern hemlock	1-3(1.7)	2-3	2-4
Balsam fir	1-3(1.9)	2-4	2-4
Northern white-cedar	1-3(1.6)	3-5	2-4
Eastern white pine	1-7(2.6)	3-5	3-5
Red pine	3-11(6.2)	3-7	3-7
White spruce	1-5(2.5)	2-6	2-6
Black spruce	1-4(1.9)	4	4-5
Jack pine	1-6(2.4)	3-4	3-4

1/ Averages shown in parentheses.
2/ As reported by Fowells (1965).
3/ As reported by Wang (1974).

seedbeds although good or better crops of other species occur at the same or even greater frequency. The ease of obtaining regeneration of sugar maple can be attributed largely to the rapid development and strength of the radicle of the germinating seed. This radicle is capable of penetrating thick layers of leaves or compacted soils to reach the moist, mineral soil, which is necessary for survival.

In other species--particularly those bearing light seeds--it is doubtful whether appreciable numbers of seeds have conditions favorable for germination on undisturbed seedbeds. Those that do germinate are usually characterized by very slow growth and weak radicles that lack the capability for survival. Therefore, establishment of regeneration in conjunction with planned cuts requires both an adequate seed supply and some degree of site preparation among light-seeded species because of their highly specific seedbed requirements.

The aspens, for example, are prolific seed producers, but the seeds seldom germinate unless the seedbeds are scarified or burned. When the seedbed is burned, aspen seedlings have been known to comprise 20 to 35 percent of all seedlings after six growing seasons even though the shelterwood overstory had no aspen and all seeds had to blow in from surrounding stands.[3]/

Other studies of site disturbance from harvesting have shown that few desirable seedbeds are created regardless of the season of logging in the Lake States (Church 1961). Therefore, site preparation required for both the germination and establishment of many species must be coordinated with good seed crops to improve the chances of securing the preferred species. The interval and duration of poor seed crops or failure are often more important than the frequency of good years. Scarified sites, for example, may revegetate to their initial cover in less than 3 years (Godman and Krefting 1960) and the benefits of reduced competition can be lost before a good or better seed crop occurs.

3/ *Unpublished data on file at the North Central Forest Experiment Station, Northern Hardwoods Laboratory, Marquette, Michigan.*

Although the annual record of seed crops provides general guides on the probability of good or better seed years, more reliable estimates of seed crops in fall-maturing species can be made from projections based on the crop size of spring-maturing red maple and American elm (table 4). Based

Table 4.--*Years between 1949-1974 that fall-maturing species had the same size seed crop as two spring-maturing species (red maple and American elm) in northeastern Wisconsin*[1/]
(In percent)

Fall-maturing species	Spring-maturing species					
	Red maple			American elm		
	Good crop (10 yrs.)	Medium crop (5 yrs.)	Poor crop (6 yrs.)	Good crop (9 yrs.)	Medium crop (3 yrs.)	Poor crop (8 yrs.)
Hardwoods						
Sugar maple	70	40	83	56	33	88
Yellow birch	60	80	83	67	67	75
Paper birch	60	75	100	56	50	88
American basswood	90	80	50	89	67	38
White ash	40	60	83	33	33	50
Black ash	22	40	67	12	67	62
Northern red oak[2/]	57	60	50	38	67	62
Conifers						
Eastern hemlock	90	60	33	89	0	38
Balsam fir	70	50	67	89	0	62
Northern white-cedar	90	100	50	89	50	50
Eastern white pine[2/]	50	40	50	44	33	38
Red pine[2/]	20	50	67	11	50	62
White spruce	60	50	50	56	0	75
Black spruce	80	50	33	78	0	50
Jack pine[2/]	70	80	17	56	33	25

[1/] Based on years both species had reported seed crops.
[2/] Requires 2 years to mature.

on the years of record now available, seed crop size of the fall-maturing species shows more consistent agreement with red maple than American elm for most hardwoods and conifers. The occurrence of good or better seed crop in red maple indicates that comparable seed crops could be expected from 60 percent to 90 percent of the time for all 1-year fall-maturing species, except white and black ash. The chances are even better for a poor seed crop or failure among fall-maturing species (especially hardwoods) if such occurs the preceding spring in red maple.

The presence of an apparent seed crop, even with site preparation, will not always assure adequate regeneration. In some years, the outer seed coat may develop but few seed may actually form. Germinative capacity is known to vary from tree to tree and from year to year; for many of the preferred species, it is relatively low.

One of the most consistent fall-maturing seed producers, American basswood, rarely reproduces from seed in many localities regardless of seedbed conditions. Of 7,435 identifiable basswood seeds we found throughout the litter on 72 1-square-foot plots under the crown perimeter of mature trees in the spring of 1973, only 2 percent were sound.[3/] All the older seeds that were covered by leaves had rotted and most of the seeds lying on or in the upper leaf layer had been destroyed by rodents. We didn't find any evidence of newly germinated or older seedlings despite the abundance of seed.

Until more specific methods can be developed to assure adequate regeneration of preferred species other than sugar maple at the time they are desired, the most successful approach should be to correlate site preparation with the occurrence of good or better seed crops. The earliest and most reliable predictions of crop size in the 1-year fall-maturing species can be obtained from the size of the crop of the spring-maturing red maple because seed crops occur at irregular intervals for most species.

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COMMON AND SCIENTIFIC NAMES OF SPECIES MENTIONED

Spring-maturing species	
Quaking aspen	*Populus tremuloides* Michx.
Bigtooth aspen	*Populus grandidentata* Michx.
Red maple	*Acer rubrum* L.
American elm	*Ulmus americana* L.
Fall-maturing species	
Hardwoods	
Sugar maple	*Acer saccharum* Marsh.
Yellow birch	*Betula alleghaniensis* Britton
Paper birch	*Betula papyrifera* Marsh.
American basswood	*Tilia americana* L.
White ash	*Fraxinus americana* L.
Black ash	*Fraxinus nigra* Marsh.
Northern red oak	*Quercus rubra* L.
Conifers	
Eastern hemlock	*Tsuga canadensis* (L.) Carr.
Balsam fir	*Abies balsamea* (L.) Mill.
Northern white-cedar	*Thuja occidentalis* L.
Eastern white pine	*Pinus strobus* L.
Red pine	*Pinus resinosa* Ait.
White spruce	*Picea glauca* (Moench) Voss
Black spruce	*Picea mariana* (Mill) B.S.P.
Jack pine	*Pinus banksiana* Lamb.

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OXFORD: 232.311.1:231.3(775). KEY WORDS: seed crop frequency, seed production, site preparation.

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